ACCELERATOR READINESS REVIEW REPORT

RHIC COLLIDER, STAR, PHENIX, PHOBOS, and BRAHMS ROUTINE OPERATIONS

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Introduction

The Accelerator Readiness Review (ARR) for RHIC has occurred in five distinct stages. First the AGS to RHIC (ATR) review, second the Sextant review, third the low intensity heavy ion commissioning, low intensity commissioning for the experiments, and now the ARR for routine heavy ion operations. This phase of the ARR deliberations does not include operations with particles other than heavy ions. Operations in other modes are to be covered in future ARR processes. In this phase of the readiness review the team has been tasked to determine if the Collider Accelerator Department (C-A) is prepared to move from commissioning to routine operations. The ARR Team reports to the Deputy Director for Operations. This report to the Deputy Director for Operations includes findings, observations (both pre-start and post-start), and final recommendations. The C-A Department will track all pre and post start items to closure and evidence of closure will be provided to the RHIC ARR Chair or his designee.

The charge of the ARR Team is to sample the RHIC processes to determine and verify that the policies, conduct of operations (procedures, personnel, and training), internal safety review program, configuration control systems, and equipment are in place prior to recommending approval for routine operations with heavy ions to BNL Management.

Review process and methodologies

Although each module of the ARR had a different scope, each module reviewed the appropriate safety documentation, the associated requirements, training, and the proposed operational safety envelope. The Team then sampled the program and processes put in to place, to ensure safe operations. The Team also reviewed documentation that all prior commitments had been fulfilled. Each subsequent ARR process reviewed the prior open issues to ensure that they had been tracked, documented, and appropriately closed out by the responsible organization.

Conclusions

The ARR Team recommends approval of the Collider and its experiments to begin routine operations. Note, that operations with protons is outside the charge of this ARR Team.

Observations

Organizational Structure

There has been a major change in the organizational structure of RHIC since the last ARR. There has been a merger of the RHIC Project and the AGS Department. The new combined organization is identified as the Collider-Accelerator Department (C-A Department). The merger of the two organizations addresses many of the prior concerns of the ARR. Those concerns having to do

with the interface issues of authority, procedural inconsistencies, operational philosophy, and conduct of operations. In this phase of the ARR process the Team examined the progress in the integration of both personnel and processes between organizations. Particular attention was placed on how the new organization captured and resolved the open issues and commitments made during prior ARR phases. The merger process is still ongoing for some systems, all the issues involving safety systems and structures have been resolved adequately to ensure safe operation of RHIC.

Conduct of Operations

Conduct of operations for both the Collider and the experiments have been examined. A broad sampling of C-A OPMs was reviewed and clearly identified lines of authority and responsibility. All the procedures addressing work planning and control relate directly to the laboratory standard for work planning and control. The procedures contained the appropriate Integrated Safety Management concepts and tools. In summary, it appears that a great deal of attention has been given to integrating the principals of conduct of operations throughout C-A Department's routine activities.

The Experimental Safety Review Committee has required experimental procedures to be in place which both to mitigate hazards and enhance communication between the experiments and C-A operations. These procedures are all in place. Of particular interest of the ARR Team is Enhanced Work Planning for Experimenters. A document in draft form "R2A2 Memorandum of Understanding for Experiments" is to be signed by the C-A Chair and the Chairs of other BNL Departments, which manage the experimental groups. These MOUs summarize the relationship between the experimental groups and the C-A Department and include requirements, which are spelled out in more detail in the C-A Conduct of Operations documents. At this time, agreements have been signed with Chemistry and Biology, but the one with Physics is still pending.

Each experimental group has produced a document "Low Hazard – Skill of the Craft Jobs and Jobs Covered by Procedure". These give examples of common tasks done by experimental personnel and indicate which is skill of the craft and which require formal planning or defined procedure. The implication is that most work, which is not low hazard, is to be done by C-A staff under their work control system. During a review of work permits issued under ES&H Standard 1.3.6 during the first four months of 2000, only one was found covering work in a RHIC experimental area. This permit was appropriate and well executed, but one might expect more permits in a complex this large and active.

Work planning for experimenters is well integrated into the work control process for the C-A Department with a post start action item that the MOUs for Experiments be completed.

Training

The C-A is the result of a recent merger between the AGS and RHIC organizations. Procedures are still being combined and certain job descriptions and the associated training requirements are still being formulated.

An Accelerator Readiness Review (ARR) for full operations must identify requirements for full operations and determine whether those requirements are met or there is a plan in place that identifies priority, resources, and time frames for completing those requirements. Therefore, training requirements identified in training profiles should be complete or properly prioritized so that fundamental safety training is completed before full operations and job task training requirements are completed as soon a reasonable.

The process used to set training requirements for individuals in the C-A Department apparently doesn't include the affected staff member on the front end of the process. The net result: staff members in leadership positions are unaware of their training requirements until they show up as untaken or expired on a individual's profile. The process of establishing requirements should include the affected individual.

Prior to full routine operations, a review of expired and untaken training is warranted. Safety related training, such as Hazard Communication, Electrical Safety, Lock Out/Tag Out, Access Training, and Work Planning should be completed. All training in accordance with the JTA should be scheduled such that it completed in a timely manner.

The PHENIX Detector Group should consider developing a document similar to "The STAR Operations Work Plan" to supplement "Skill of the Trade" agreements. If the STAR Detector User training "school" is successful, PHENIX may also wish to consider the applicability of developing User training "schools" to assist shift workers to function safely and successfully.

It is noted that the C-A Department has developed a comprehensive program to address and correct the deficiencies in the training program that is expected to be completed before the end of CY 2000.

Safety Off Modes (Analysis of Critical Devices)

Engineering analyses have been made of devices critical to safety shutdown of RHIC beam. Tom Dickinson reviewed these with Dana Beavis for RHIC ARR acceptance.

The RHIC ring beam stop is a mechanical device and was reviewed by the C-A Department Chief Mechanical Engineer. One potential problem is that the air system supplying this device has a safety relief at 150 psi while the solenoid valves are rated at only 125 psi. This was corrected by changing the relief

pressure. Another is that the beam stop may suffer damage if it is inserted when there is beam in the machine, and be compromised for subsequent beam stopping. The solution is to require insertion tests of the beam stop before beam is re-injected in the event that the stop has been inserted with beam in the machine. The correction and solution to these potential problems is adequate.

The critical devices for injected beam safety are the power supplies selected magnets, which can limit the path of injected beam. For example, the power to the switching magnet and to the X and Y magnet strings is turned off to prevent the beam from reaching areas downstream of the X and Y magnet arcs. The C-A Department Chief Electrical Engineer reviewed the implementation of this power turn-off. The conclusion is that the methods used are standard and reliable. There are at least two independently operated critical devices used to provide protection for each area for redundancy.

Sweep Procedures

The sweep procedures for the RHIC tunnel have been established and in use for more than a year. This review examined sweep procedures for the experimental areas.

The sweep procedures for the Star, Phobos, and Brahms experimental areas are regular OPMs. The sweep for Phenix is a temporary procedure since this experiment is still under construction and the sweep procedure is expected to change as construction comes to completion. All of the procedures are in routine use. The Star and Brahms areas were visited for a walk down of the sweeps and they were found them to be well laid out and comprehensive.

Access Control Systems

The RHIC Particle Accelerator Safety System (PASS) has been the subject of continuing development and review since 1995. This review examined experimental area access control, system tests done in preparation for beam commissioning, and experience with the overall system.

Access control for the experimental areas has been implemented with the same hardware and procedures as used in the RHIC tunnel. Access cards are encoded for specific experimental areas to limit access to those qualified to enter these areas. The test forms for recent system tests were reviewed. The resolution of problems that occurred during these tests had been done in a satisfactory way and included correction of typographical errors and minor changes in tests which could not be completed as written. A member of the C-A safety staff signs off the test reviews, and the corrections and changes mentioned had his concurrence.

The operator interface in the control room was examined, and this is a vast improvement over the earlier version of this interface. The present system provides operator status indications on a geographical layout and also has TV and

intercom monitoring of access gates for controlled access activities. The C-A operations group had substantial input during the design of this interface.

The RHIC PASS now appears to be in a mature and stable state, and the weaknesses identified in previous reviews have been corrected.

Safety Documentation

The C-A Department currently possesses a Safety Assessment Document (SAD) for RHIC that has been approved by Laboratory Management. Chapter 5 of the SAD includes the approved Accelerator Safety Envelope (ASE) and Operational Safety Limits (OSLs) for STAR and PHENIX, which was approved by DOE. It should be noted that the ASE and OSLs have had significant revision and are currently in the review process. The revised ASE and OSLs address many of the problems noted in the prior ARR reviews. PHOBOS and BRAHMS are small experiments, and deemed to be below the threshold for requiring additional safety limits over and above those required for conventional safety and are not included in the OSLs. These two experiments were reviewed by the RHIC Experimental Safety Committee.

ORRs

The ORR process for RHIC and the detectors is complete. There are seven open post start issues that are being tracked by the C-A Department to closure. The owner of the ORR process, Mr. Monahan, is satisfied with the closure process of the prior open issues and the current tracking of the post start issues.

Prior open ARR issues

There were 13 prior commitments from the RHIC Low Intensity ARR Report. These items were carried as items 100 through 112 in the C-A Department's commitments tracking system. The status is as follows:

Commitment 100: Revise the AGS Conduct of Operations Conformance Matrix to encompass all applicable procedures for both AGS and RHIC. The new C-A Department Conduct of operations Matrix was signed off on October 1, 1999. Status: Closed

Commitment 101: Incorporate explicitly the configuration control of the RHIC SAD and ASE in the RHIC configuration control documents. The C-A Department has established a procedure C-A OPM 1.10.1 to document changes that affect the SAD and ASE. Status: Closed.

Commitment 102: Continue with enhancement of communications by installing PA systems between MCR, experimental areas and other areas and other areas determined to be necessary. This item is closed for the experimental areas at the Collider. This item will remain open until closed by the Fire and Rescue Group

and their concerns of fire/rescue operations in the Collider tunnel complex. Status: Open

Commitment 103: It is necessary that an FMEA be performed on all critical devices where design documentation/review is not available. This item was discussed earlier in this report. Status: Closed.

Commitment 104: Present results of the scheduled fault testing program before routine operations. The results of the prior fault testing using TLDs have been reviewed with the ARR Team. Additional fault studies are planned and a report will be written at the end of the first running period. Status: Closed.

Commitment 105: Notify the ARR Team when the beam abort system is complete and ready for review. The beam abort system was reviewed by the C-A Radiation Safety Committee. Status: Closed.

Commitment 106: Develop a plan to transition the RHIC commitment tracking system from RHIC to the new organization. The items in the RHIC commitment tracking system have been captured by the C-A Department and are being tracked to closure. Status: Closed.

Commitment 107: The ASSRC and ORR post start-up issues needed to be assigned a projected or required closure date. Responsible individuals and closure dates have been assigned. Status: Closed.

Commitment 108: Revise RHIC OPM 2.4 to assign responsibility and the mechanism for the maintenance of the RHIC OSLs. The C-A Department has drafted C-A OPM 2.5.2, RHIC Operational Safety Limits and a new ASE for the Collider. These documents have been submitted to the Laboratory ESH Committee for review. The modification process is addressed under the C-A Department USI process described in C-A Department OPM 1.10.1. The proposed ASE has been submitted to the DOE Brookhaven Group for review and approval. There is currently in place an approved Commissioning ASE and an ASE for Routine Operations, September 20, 1999. Status: Closed

Commitment 109: Transmit to the ARR Team documentation of the OSL compliance for the RHIC detectors. C-A has developed checklists to be completed by C-A and Experiment personnel for each of the experiments to document their compliance with the OSLs. However, for ongoing use of these forms ARR and ORR personnel should not be included as signatories. Status: Closed.

Commitment 110: Develop a long term maintenance and surveillance program for the fencing and shielding including the berm as required by the RSC. The C-A Department has developed OPM 8.10.2 and FES# A.13.0 to address this issue. Status: Closed.

Commitment 111: Notify the ORR Chair when the beam collimators are ready for review. The beam collimators have undergone ORR review. Status: Closed.

Commitment 112: ORR Closure documentation needs to be finalized. ORR closure documentation has been developed for the 47 items that have been closed. The remaining 8 items have been scheduled for closure in agreement with the ORR Chair. Status: Closed.

Recommendations from ARR for the experiments:

1. OSLs need to be revised to clarify the two modes of operation for PHENIX. The C-A Department will use the "blue sheet" process to certify and discriminate between the two different modes of operation for PHENIX. Status: Closed.

2. That RHIC/AGS Incorporate the OSLs into a checklist or matrix for summary compliance verification that documents how the OSLs have been satisfied. See Commitment 109. Status: Closed

3. The responsibility of the Detector Shift Leader and the Main Control Room Operations Coordinator needs to be documented in the AGS Conduct of Operations Program. For the Commissioning run the "Guidelines for RHIC Detector Operations for Commissioning", (approved 7/30/99) was made required reading for both the Detector Shift Leaders and the MCR Operations Coordinators. This document covered policy, detector operations, sweeps, etc. Currently these requirements have been incorporated into the C-A operational procedures such as C-A OPM 4.56ao, RHIC Zone 6zl/STAR Sweep Checklist, and C-A OPM 11.2.1, Preparation of the PHENIX Central Magnet for Routine Operation. Status: Closed

4. RHIC needs to evaluate the availability of emergency procedures in hard copy at the experiments. C-A will provide paper copies of the emergency procedures to address this issue. Status: Closed.

5. Post Start items from prior ARRs have not been assigned closure dates. See Commitment 107. Status: Closed

6. Maintenance of RHIC Commitments database in the transition to the combined AGS/RHIC organization needs to be addressed. See Commitment 106. Status: Closed

Readiness Determination

The ARR Team recommends approval of the C-A Department's request to begin routine operations using heavy ions in the Collider and its experiments.

Appendices

Pre-Start Findings

Post-Start Findings

Suggestions for Improvement

PRE-START FINDINGS

None

POST-START FINDINGS

1. Complete the corrective actions for the training program by the close of CY 2000.

2. Complete the Fault Study and develop the final report by the close of FY 2000.

3. Continue with enhancement of communications by installing PA systems between MCR, experimental areas and other areas.

4. ORR Closure documentation for the seven items open needs to be finalized.

Suggestions for Improvement

The PHENIX Detector Group should consider developing a document similar to "The STAR Operations Work Plan" to supplement "Skill of the Trade" agreements. If the STAR Detector User training "school" is successful, PHENIX may also wish to consider the applicability of developing User training "schools" to assist shift workers to function safely and successfully.